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Indian Standard

LIFE TESTING OF DIGITAL MICROCIRCUITS

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Indian Standard
LIFE TESTING OF DIGITAL MICROCIRCUITS

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Indian Standard

LIFE TESTING OF DIGITAL MICROCIRCUITS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 24 April 1981, after the draft finalized by the Semiconductor Devices and Integrated Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard deals with the life test procedure for digital microcircuits applicable for approval purposes as well as for reliability evaluation. It also includes recommended electrical conditions.

0.3 Assistance has been derived in preparation of this standard from IEC Pub 147 — 4 Essential ratings and characteristics of semiconductor devices and general principles of measuring methods: Part 4 : Acceptance and reliability issued by International Electrotechnical Commission (IEC).

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard deals with life test procedure for digital microcircuits (Bipolar, MOS, and multi-chip circuits) applicable for the following purposes:

a) Type approval or type testing,
b) Acceptance testing, and
c) Reliability evaluation.

2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions as specified in IS : 2500 (Part I)-1973† and IS : 2612-1965‡ shall apply.

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*Rules for rounding off numerical values (*revised*).

†Sampling inspection tables: Part I Inspection by attributes and by count of defects (*first revision*).

‡Recommendation for type approval and sampling procedures for electronic components.

3. CONDITIONS FOR TESTING

3.1 Unless otherwise specified, all measurements shall be carried out under standard atmospheric conditions as specified in IS : 9000 (Part I)-1977*.

3.2 The device should be operated under steady state (ac or dc as appropriate) conditions. In some cases, intermittent or other modes of operation may be necessary as supplementary tests.

3.3 Mounting Provisions

3.3.1 *Ambient Rated Device* — The free lead length between the point of emergence of the leads from the case and the electrical contacts or supports should preferably be not less than 5 mm for devices having leads of uniform cross-section throughout their length. When a design feature (for example, a change in lead cross-section or a bend) is provided to limit the depth of insertion of the device into its mounting, the contact or support should be placed as close to this feature as is practical, on the end of the lead away from the device.

Devices with lead length less than 5 mm should be mounted in accordance with the manufacturer's recommendation. The contacts or supports shall be at a temperature not lower than ambient temperature.

3.3.2 *Case Rated Device* — Provision shall be made which assure that the specified case temperature is maintained.

3.4 Test Circuit and Test Conditions — The test circuit and conditions specified in Table 1 are applicable to Bipolar, MOS and hybrid (multi-chip) unless otherwise specified.

3.5 Operating Conditions

3.5.1 *Thermal Endurance (Life) with Electrical Loading* — The operating voltage used for electrical stress should be rated in the relevant individual specification. The voltage is applied according to Table 1.

Unless otherwise specified initial tolerances and any variation of the voltage during operation shall be within ± 5 percent of the specified voltage at the device terminals.

The output current should be specified in the relevant detail specification.

The ambient temperature at which the devices are operated shall be maintained at ±5°C of the operating temperature $t_{op\ (max)}$. (*see* Table 1).

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*Basic environmental testing procedures for electronic and electrical items: Part I General.

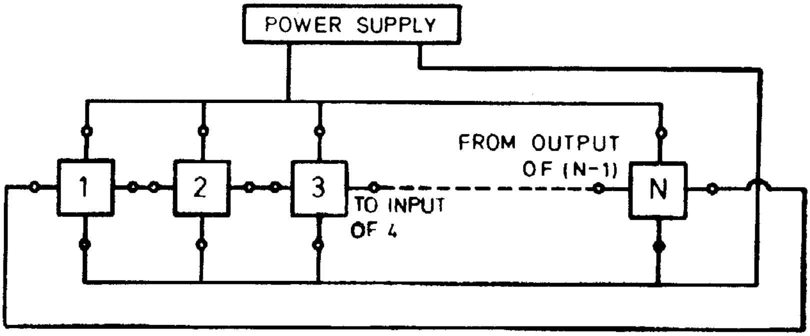
TABLE 1 ELECTRICAL TEST CONDITIONS

(*Clauses* 3.4 *and* 3.5.1)

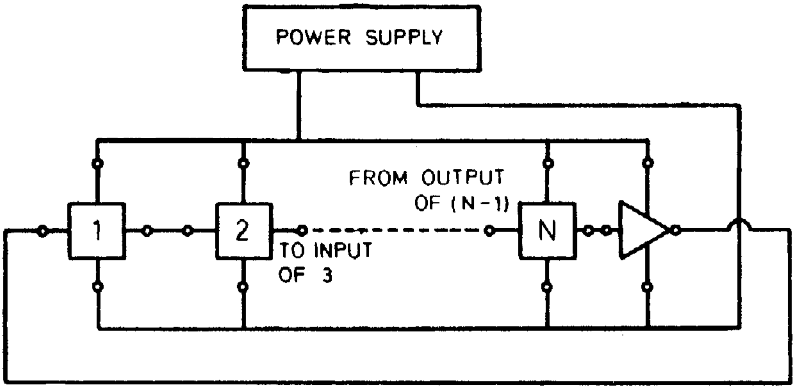
SL No.	TEST	DEVICE CATEGORIES	TEST CONDITIONS	
			Temperature	Operating Conditions
(1)	(2)	(3)	(4)	(5)
i)	High temperature ring oscillator	Gates	$t_{amb} = t_{op\,(max)}$	For the case of inverting type gates, an odd number of integrated circuits is connected in cascade, the output of the last gate being connected to the input terminal of the first gate, as shown in Fig. 1A to cause phase inversion For the case of non-inverting type gates, an inverter should be added to the cascade connection of non-inverting gates as shown in Fig. 1B. In this case, the number of non-inverting gates may be odd or even
ii)	High temperature dynamic operating life	Gates sequential circuits	$t_{amb} = t_{op\,(max)}$	The specified pulse train(s) is (are) applied to the specified input terminal(s). The conditions at the other terminals should be specified
		Read/write memories	$t_{amb} = t_{op\,(max)}$	The specified pulse train(s) is (are) applied to the specified input terminals. The conditions at the other terminals should be specified
iii)	High temperature dynamic operating life	Gates sequential circuits except: 1) dynamic (MOS) circuits 2) read/write memories	$t_{amb} = t_{op\,(max)}$	The specified voltages are applied to the input terminals. The conditions at other terminals should be specified
		Read/write memories	$t_{amb} = t_{op\,(max)}$	The specified voltages are applied to the appropriate specified terminals, so as to write in specified data, read it out and retain it

NOTE 1 — The relevant detail specification should specify the applicable tests.

NOTE 2 — The high temperature static operating life test is not applicable to dynamic MOS circuits such as shift registers.



1A Inverting Gate Ring Oscillator (N: Odd Number)



1B Non-Inverting Gate Ring Oscillator (N: Any Number)

FIG. 1

3.5.2 *Thermal Endurance* — The device shall be exposed to specified rated maximum ambient or reference point temperature chosen from the list of temperatures given below:

+ 40°C
+ 55°C
+ 70°C
+ 85°C
+ 100°C
+ 125°C
+ 150°C
+ 175°C
+ 200°C
+ 250°C
+ 300°C

3.6 Operating Temperature — The ambient temperature at which the devices are operated shall be maintained at ±5°C of operating temperature t_{op} $(_{max})$ (*see* Table 1).

4. DURATION OF LIFE TESTING

4.1 Duration of life test shall be selected from Table 2. If intermediate measurements are made, they shall also be performed at the time of intervals given in the table up to 2 000 hours and then after every 2 000 $^{+48}_{-50}$ hours until the required duration has elapsed.

TABLE 2 DURATION OF LIFE TEST

168 $^{+16}_{-10}$ h	
336 $^{+16}_{-20}$ h	
672 $^{+20}_{-30}$ h	
1 000 $^{+36}_{-30}$ h	
2 000 h	
5 000 h	(*see* Note)
10 000 h	

NOTE — Extended life tests for 5 000 and 10 000 hours may be carried out for evaluation of reliability of the devices which meet the conditions of life test as a type test.

5. MEASUREMENTS

5.0 The life test shall be conducted on integrated circuits which have passed all other relevant tests. The selected samples shall be subjected to life test for the duration and under conditions stated in the individual specification. Duration shall be selected in accordance with Table 2.

5.1 Measurements shall be made as near as possible to the specified time but may be adjusted so that the measurements need not be made during other than normal working days; however, in no case the time deviation shall exceed 72 hours.

5.2 A few characteristics only should be selected for each device category which are of major inportance for the specified device category.

NOTE — Characteristics to be specified in the relevant specification shall be measured in the sequence in which they are listed because of change of characteristics caused by some failure mechanism may be wholly or partially marked by the influence of other measurements.

5.3 All characteristics specified in the individual specification shall be measured before and after life tests, unless otherwise specified. Measurement of characteristics at the end of the test shall be made within 72 hours after completion of the test.

5.4 Measurement shall be made at ambient temperature as specified in **3**.

5.5 When only attributes analysis is planned, data may be taken by making measurements on a go/no-go basis (measured values are compared with specified limits, and the device is considered to be passed or failed). When variables analysis is planned, devices shall be individually identified and the value of each specified characteristics of each device shall be measured.

6. REQUIREMENTS FOR TESTING

6.1 The following information shall be provided in the detail specification:

a) *Device Categories* — The relevant individual specifications shall state which test(s) shall apply.

b) *Failure Defining Characteristics* — For multiple devices, the specified output characteristics shall be measured for each associated input. For devices having additional control terminals (for example, set and clear terminals, enable terminals), the specified outputs shall be measured at least once for each function controlled by these terminals.

NOTE — When compler circuits are not subjected to complete functional tests, the test data shall indicate exactly those functional tests which are performed.

c) *Electrical Stress Conditions* — Test conditions and test circuits, for each device category as listed in Table 1.

7. FAILURE CRITERIA

7.1 Each device which, after the life test, does not meet the limit specified for one or more of the characteristics for a device category shall be considered a failure. In determining the failure, the measurements may be referred to values measured at 25°C when necessary.

8. PRECAUTIONS TO BE OBSERVED

8.1 Measurement may be made in any sequence, unless otherwise specified.

8.2 Bias voltages and/or currents shall be supplied to devices for a total time equal to the specified test time (within the allowed tolerance). It is preferable that bias voltages continue to be applied to the device until they have cooled to room temperature, unless it can be established, for the given device type and test conditions, that no significant change of characteristics occurs when the device is cooled with the bias removed.

8.3 Where appropriate, steps should be taken to prevent oscillation.

9. FAILURE CRITERIA AND FAILURE DEFINING CHARACTERISTICS FOR ACCEPTANCE TESTS

9.1 For acceptance testing, no change of limits of static and functional requirements of characteristics chosen in **5.2** and **5.3** shall be allowed for digital integrated circuits.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2